ECONOMICAL ENGINE OPERATION

Ingenious Features of the Cambridge Mixture Indicator : Exhaust Gas Continuously Analysed

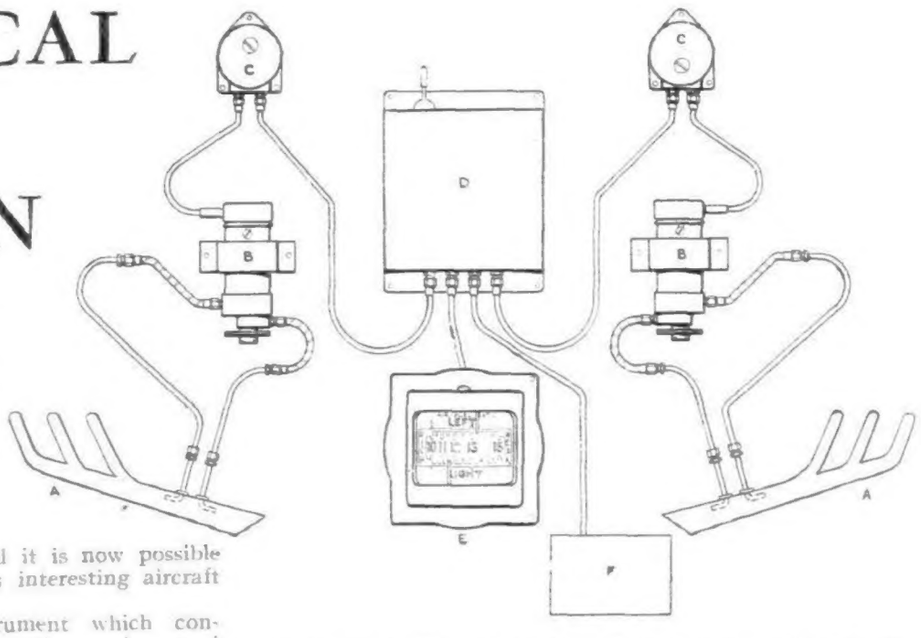
IT may be recalled that in *Flight* of September 3 reference was made to the Cambridge mixture indicator, and it is now possible to give a detailed description of this interesting aircraft accessory.

The indicator is a dashboard instrument which continuously analyses the exhaust gas from the engine, and shows the result of this analysis on a scale calibrated in air-fuel ratio over a range of from 10 to 15. Its readings enable the pilot to adjust the mixture ratio to give the most efficient results under varying conditions of flight.

The value of the instrument does not end here. It operates as a warning signal by indicating any changes in the mixture strength due to variations in the conditions under which the engine is operating, *e.g.*, a change in throttle position, in carburetter air temperature or scoop pressure, in altitude, or a drop in the fuel supply pressure. The instrument also indicates detonation by a fluctuation of the pointer followed by a slow movement toward the rich end of the scale.

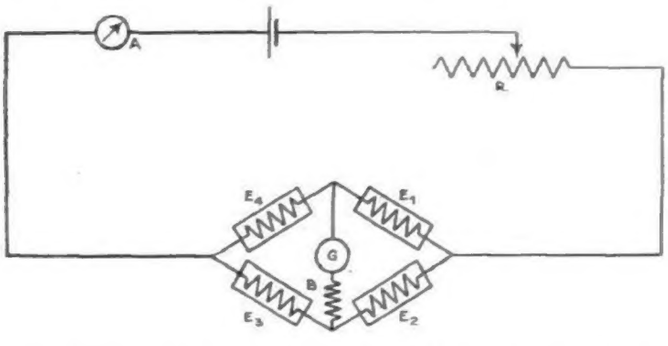
The makers state that a series of tests carried out by a leading airline have shown that from 10 to 12 per cent. of fuel may be reasonably expected to be saved by the use of the Cambridge indicator

The instrument works upon the well-known thermal conductivity system of gas analysis, utilising the katherometer devised by Dr. G. A. Shakespear. If a platinum wire, surrounded by a gas in a chamber, is connected to a source of constant electromotive force, the temperature of the wire will rise until a condition of equilibrium is reached, when the continuous dissipation of thermal energy is equal to the electrical energy supplied to the wire. The thermal energy is dissipated in several ways, but such is the design that only one factor, thermal conductivity of the surrounding gas, is decisive. The temperature attained by the wire when equilibrium is reached depends on this factor. The temperature of the wire may be determined by measuring its electrical resistance, the current which heats the wire being used for this purpose.



A schematic diagram (not to scale) of a twin-engine layout: AA, exhaust manifolds ; BB, analysers ; CC, balancing boxes ; D, control box ; E, dashboard indicator ; F, battery.

In the Cambridge analyser, four identical spirals of platinum wire are enclosed in separate cells E_1, E_2, E_3 and E_4, in a metal block, as shown diagrammatically in the smaller drawing. Each of these spirals forms one arm of a Wheatstone bridge circuit. A current is allowed to flow through the bridge, thereby causing the spirals to become heated and to lose heat to the walls of the cells. If two gases having different thermal conductivities are introduced, one into two of the cells (say, E_1 and E_3), and the other gas into the other two cells (E_2 and E_4), the spirals E_1 and E_3 will cool at a rate different from that of E_2 and E_4, and will, therefore, be maintained at a different temperature. The consequent difference in the resistance of the spirals will throw the Wheatstone bridge out of balance, causing a deflection of the galvanometer G, the extent of which depends upon the difference in the conductivity of the two gases The construction is such that changes in the temperature of the gases affect both sides of the bridge equally. If, therefore, the cells E_2 and E_4 contain a pure gas and the cells E_1 and E_3 the same gas mixed with some other constituent, the extent of the deflection will be an indication of the amount of the second gas present, and the galvanometer can be calibrated to show directly the percentage composition of the mixture.



This diagram of the analyser principle should be studied in conjunction with the text.

The analyser is mounted on the engine frame, and a sample of the gas from the exhaust manifold is caused continuously to flow through it by the pressure difference set up between the stainless steel pipes which project into the gas stream. The analyser is electrically connected to balancing and control boxes in the pilot's compartment, and the control box is wired to the indicator on the dashboard (see larger diagram). A filter cartridge within the analyser is easily removed, cleaned and replaced. The total weight of an outfit for a dual engine plane is 7lb. 11oz., and the only portion that requires to be accommodated on the dashboard is the indicator, the size of which is 4in. by 4¼in. by 4¼in.

The makers are the Cambridge Instrument Co., Ltd., 15, Grosvenor Place, London, S.W 1.

RECLAIMING LUBRICATING OIL

MOST engineers are acquainted with the Sharples Centrifuge, which is used extensively for the renovation of used lubricating oils. These machines are simple in construction and operation, and are stated to produce a centrifugal force of well over 13,000 times that of gravity. By the utilisation of this exceptional force, used lubricating oils can be completely clarified, i.e., moisture, carbon and metallic particles are extracted rendering the oil suitable for re-use. It is stated that lubricating value is not impaired in any way whatsoever, and that these machines have been employed on such work for many years in almost every country in the world.

The makers, Super-Centrifugal Engineers, Ltd., Sharples House, 101, Grosvenor Road, London, S.W.1, state that they would be pleased to examine samples of used oils, returning samples of the renovated product with a full report, this work being done without any obligation. The factory in which the Sharples Centrifuge is made is situated at Stroud, Gloucestershire, and is known as the Lightpill ironworks.